

# Exhibit 14

***Talc***  
***Geology, Mining and Processing for***  
***Cosmetic, Pharma and Food Applications***

**E.F.McCarthy**

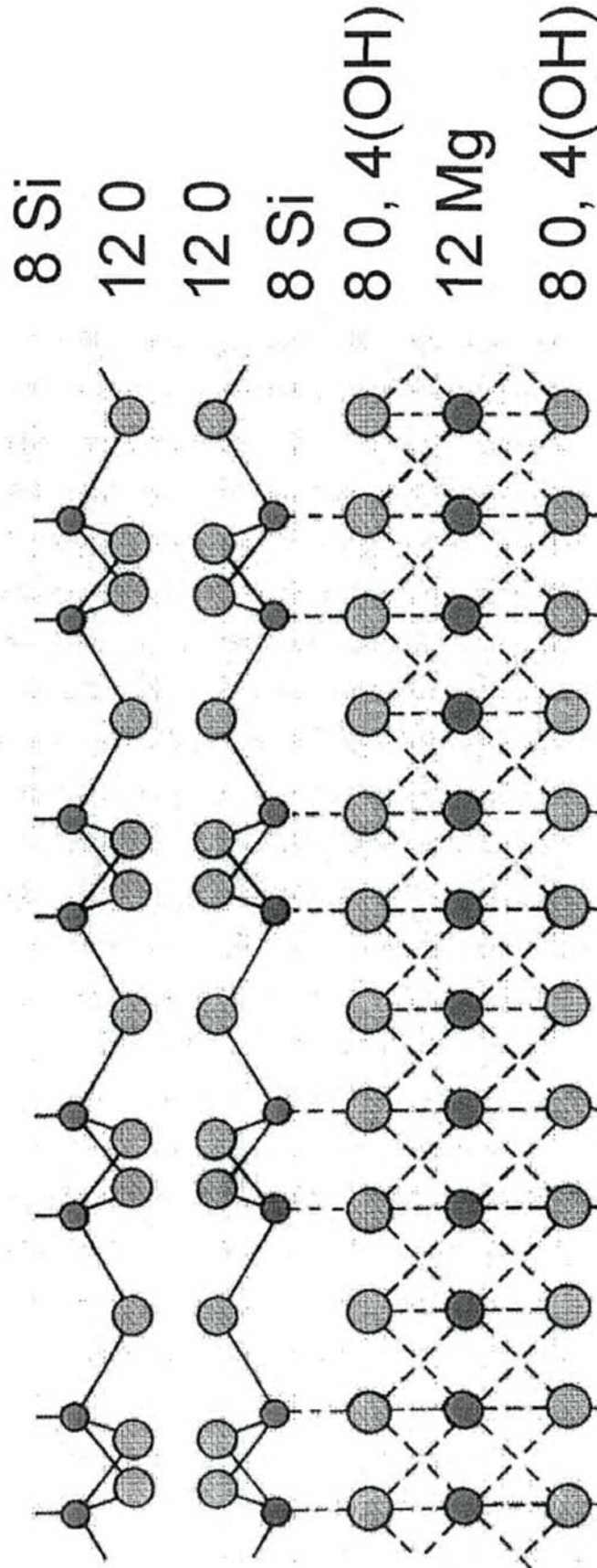
**February 2010**



# ***Talc***

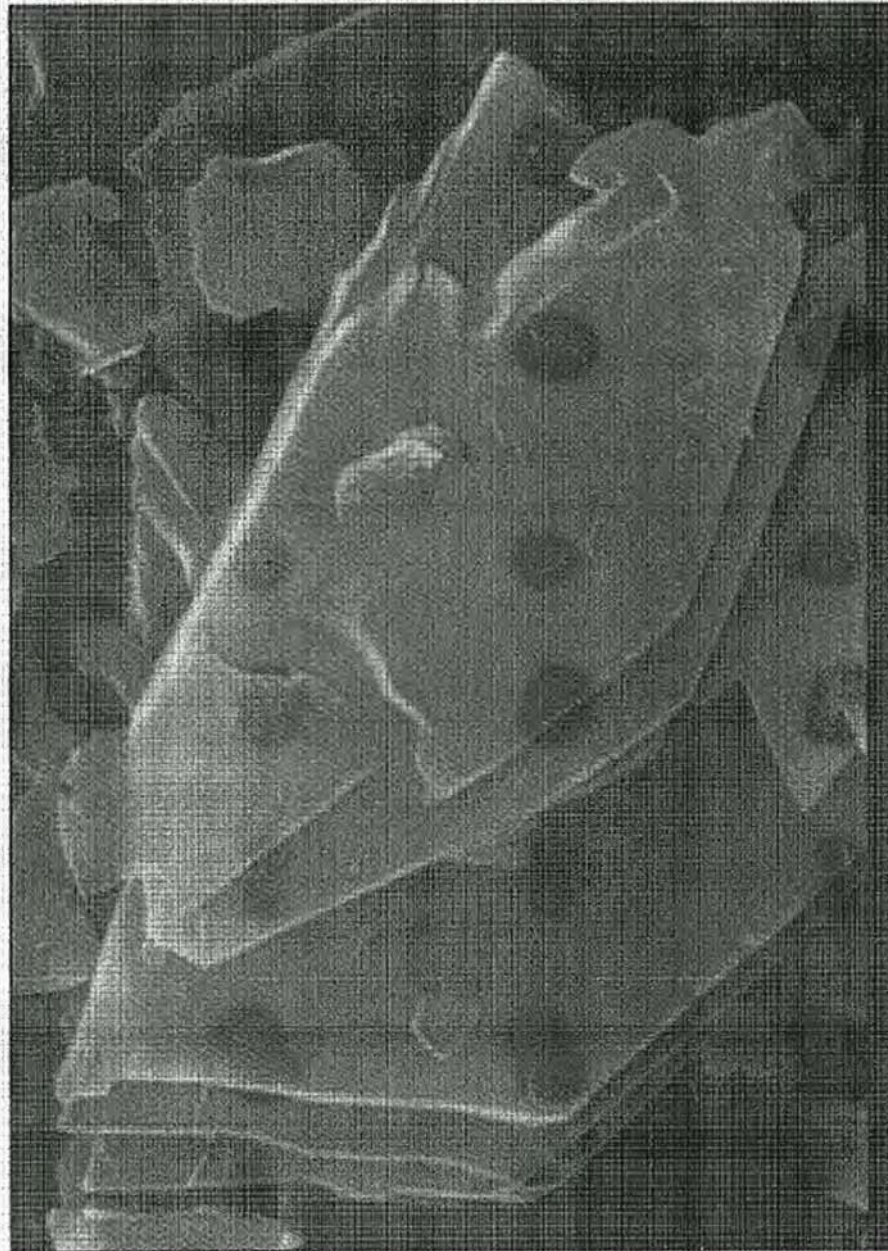
- **Hydrous magnesium silicate**
- **Layered phyllosilicate**
- **$3 \text{ MgO} \cdot 4 \text{ SiO}_2 \cdot \text{H}_2\text{O}$**
- **Platy structure**
- **Soft and relatively inert**

# Talc Crystal Structure





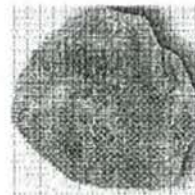
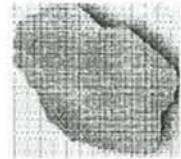
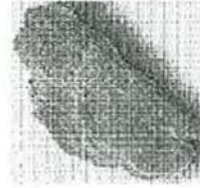
Micrograph of Stellar Talc - SEM



1 Micron

**Luzenac**

**Every talc is different**



# ***Talc Geology-Overview***

- Occurs as a pure mineral and as a mixture with other minerals
- China, India, USA, Finland, France, Brazil major producers
- Montana, Vermont, Texas, Ontario
- Luzenac Montana deposit is highest talc content orebody mined today
- Luzenac –Ontario product is purest beneficiated talc product produced in world





# ***Talc-Petrogenesis***

- **Four different paths to talc formation**
  - **Ultramafic**      **Vermont, Finland**
  - **Mafic**      **Virginia**
  - **Metasedimentary**      **Montana, China**
  - **Metamorphic**      *NY State, California*





# *Talc of Ultramafic Origin*

- Host dark rock, containing  $\text{SiO}_2$  &  $\text{MgO}$  is first converted to serpentinite under high temp & pressure
- Serpentinite is carbonized to form talc and magnesium carbonate
- $3\text{MgO} \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O} + 3\text{CO}_2 \gg 3\text{MgO} \cdot 4\text{SiO}_2 \cdot \text{H}_2\text{O} + 3\text{MgCO}_3 + \text{H}_2\text{O}$
- Vermont, Ontario, Finland, Karelya-Russia
- Most abundant type of talc deposit
- High in carbonate, Fe, transition metals
- Not used for cosmetics unless beneficiated by floatation

# ***Talc of Metasedimentary Origin***

- Host dolomitic rock hydrothermally altered by silica containing fluids
- $3 \text{ Ca.Mg}(\text{CO}_3)_2 + 4\text{SiO}_2 + \text{H}_2\text{O} \gg 3\text{MgO}.4\text{SiO}_2.\text{H}_2\text{O} + 3\text{CaCO}_3 + 3\text{CO}_2$
- Montana, China, India, Brazil, Australia
- Most important type commercially exploited
- Almost all cosmetic talc supplied from this ore type



# ***Talc of Metamorphic Origin***

- Host dolomitic silica metamorphised to tremolite or actinolite and carbonate
- Tremolite metamorphized to talc and calcium silicate
- $5\text{Ca.Mg}(\text{CO}_3)_2 + 8\text{SiO}_2 \gg 2\text{CaO}.5\text{MgO}.8\text{SiO}_2.\text{H}_2\text{O} + 7\text{CO}_2 + 3\text{CaCO}_3$
- $2\text{CaO}.5\text{MgO}.8\text{SiO}_2.\text{H}_2\text{O} \gg 3\text{MgO}.4\text{SiO}_2.\text{H}_2\text{O} + 2\text{CaSiO}_3$
- NY State, Madoc, ON, Death Valley, CA
- Almost no cosmetic talc source from this ore

# **Talc Ore Mineralogy (Cosmetic Source)**

Mineral	Montana	Vermont	Australia	China	India
Talc	>90	50-70	85-95	60-95	80-95
CO3	<5	30-45	<3	1-30	2-10
Chlorite	<10	3-7	1-12	1-15	1-5
Tremolite				0-5	
Serp'tine		1-5		trace	tr
Quartz	0-1	trace	0-1	0-1	0-1



# Talc Ore Chemistry

Oxide	Montana	Vermont	Australia	China	India
SiO <sub>2</sub>	58-61	30-40	58-60	52-62	55-62
MgO	29-32	28-32	27-30	25-32	25-32
CaO	<2	<3	0.2-2	1-8	0.5-5
Al <sub>2</sub> O <sub>3</sub>	<5	2-6	1-6	1-3	0.5-3
Fe <sub>2</sub> O <sub>3</sub>	~1.4	4-8	<0.3	<1	<1
LOI	5-8	18-30	3-7	5-7	5-9





## ***Talc Mineralogy (ore)***

- Montana-Luzenac 98% talc, 2% dolomite, chlorite, quartz
- Montana –MTI 80-90% talc, 2-10% chlorite, 1-5% CO<sub>3</sub>
- Vermont 50-70% Talc, 3-4% chlorite, 30-45% carbonate (ferroan magnesite), magnetics
- Australia talc 85-95, chlorite (magnesium aluminum silicate) 2-12% , <5% carbonate, quartz
- China 60-95% talc, carbonates, chlorite, quartz



# ***Talc Chemistry Variations***

- In most talc ores,  $\text{Fe}^{+2}$  substitutes for  $\text{Mg}^{+2}$  in lattice - not removable
- In serpentine derived talc, it is common for other transition metals like  $\text{Cr}^{+2}$  and  $\text{Ni}^{+2}$  to also substitute for  $\text{Mg}^{+2}$  in lattice – not removable but also not bioavailable
- Two crystalline analogues of talc, pyrophyllite (Al) and Minnesotite(Fe) exist but rarely occur with talc
- Aluminum almost always occurs as chlorite in talc ores



# Talc Terminology

- Steatite (massive)
  - higher purity (machinable) talc ore
  - ceramic insulator composition (~80% talc)
- Soapstone
  - Talcose ore that can be carved into blocks
  - Serpentine derived ores
- Tremolitic Talc
  - Ores containing mixtures of tremolite and talc, typical of NY State and well known for beneficial ceramic and paint uses



# ***Talc Mining***

- Ore body defined by drilling – mine plan prepared
- Most talc now mined by conventional open quarry, drill and blast, benching techniques
- Overburden removed
- Close spaced blast hole drilling, analysis of holes
- Ore selection at mine face by selective blasting and shovel operation
- Waste to ore ratios >5/1 for massive ores, <2/1 for soapstone ores





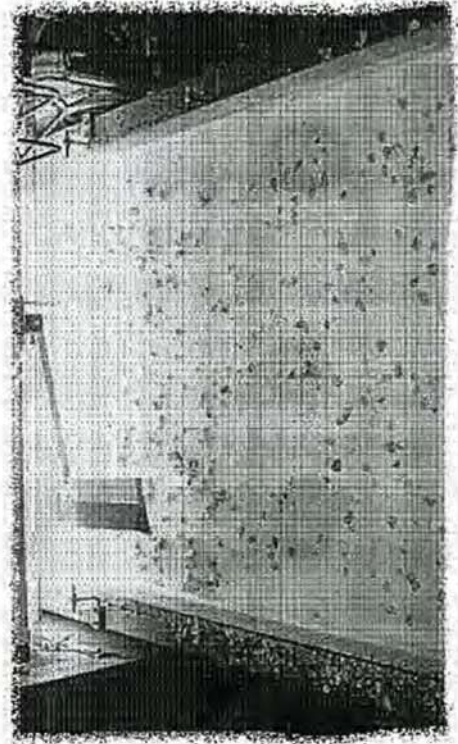
## *Overburden removal*



## *Talc extraction*



## *Sorting*



**Luzenac**



# ***Talc Beneficiation***

- **Massive Ore (>80% talc)**
  - Friction sorting, manual sorting, color sorting, shape sorting, froth flotation, selective grinding
  - Manual sorting, froth floatation and color sorting used to prepare ores for cosmetics
- **Lower Talc Content Ores**
  - Froth flotation, tabling, acid washing, magnetic separation, selective grinding
  - Froth floatation, acid washing and magnetic separation used fro preparing cosmetic ores

# ***Talc Beneficiation***

- Rejection of non talc minerals
  - Carbonates, quartz and serpentine are quantitatively removed by friction sorting and froth floatation
  - Manual sorting can only remove minerals that are liberated above a 1" particle size
- Rejection of fibrous minerals
  - Can be selectively rejected and levels reduced by flotation and manual sorting, but they cannot be eliminated to meet cosmetic standards
  - Only strong acid digestion, which is not an economically viable process, can completely eliminate these contaminants



# ***Talc Ore Testing***

- **Visual Geology**
  - **General ore quality, softness, petrology, absence of fibers, pyrite, quartz and feldspars**
- **Thermal/Chemical/Physical**
  - **Loss on ignition, acid solubles, brightness, feel, extractable metals**
- **Microscopy, XRD**
  - **PLM, TEM, XRD**

# ***Talc-Crystallinity & Morphology***

- **Crystal size of talc can vary from 5 up to 300 microns (microcrystalline, macrocrystalline)**
- **Although talc is a platelet, shape of talc particle can vary from round to a disordered orthorhombic structure, (cabbage, rosette) to disordered platelet (shaved wood), to a more uniform platelet, to (very rarely) a fiber**
- **Additionally, finely milled talc agglomerates readily and it is sometimes difficult to distinguish an agglomerate and a primary particle**





# ***Macrocrystalline Talc***



**74 Luzenac**



# ***Microcrystalline Talc***



**Luzenac**

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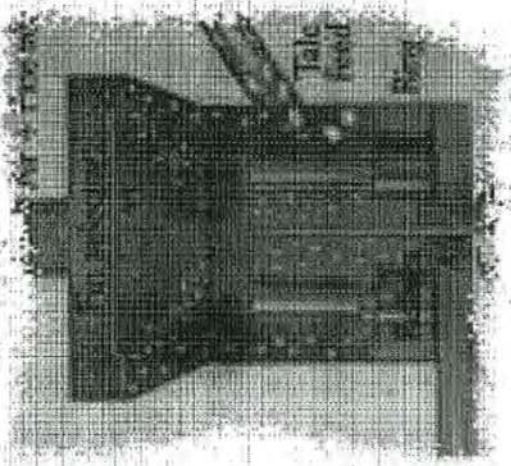
# ***Talc Processing***

- **Particle size reduction/control**
- **Microbiological control**
- **Packaging**
- **Delivery systems**
- **Surface modification**

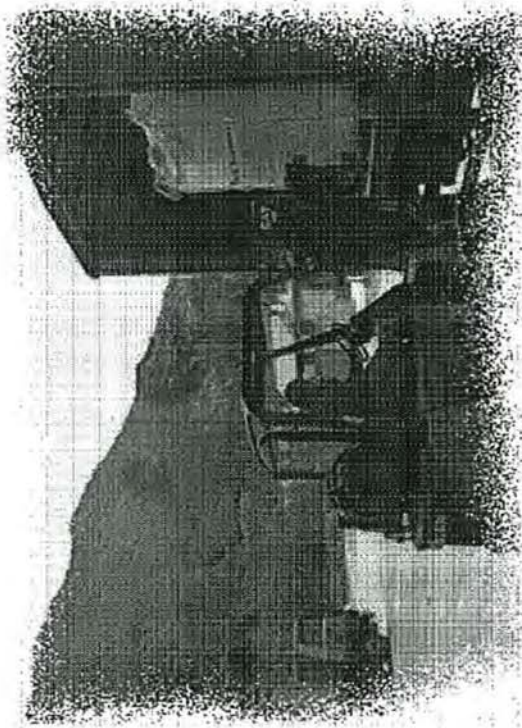




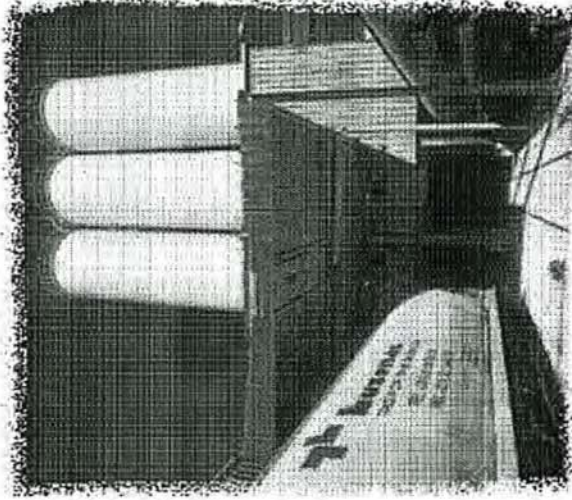
## ***Milling***



## ***Packaging***



## ***Shipping***



# ***Talc Processing Issues***

- Talc is very soft and relatively easy to mill
- Ring roller milling is preferred as it delaminates as opposed to fracturing the ore
- Talc will tend to overproduce fines and most milling processes limit this by controlling product bulk density as well as top size
- The most common grades have bulk densities of 20-30 lbs/ft<sup>3</sup> and a top size of >98% passing 200 mesh for powders
- Milled talc has a very high level of surface energy which causes particles to agglomerate



# *Microbiological Control*

- Talc is not a good substrate for bacterial growth
- Bacteria can be introduced into the ore by moisture or organic contaminants during transport or storage
- A short thermal shock ( 1 minute at 350 F) will kill most micro-organisms and thermal treatment is the most common method of bacterial control
- If the ore is floated, chlorine or hypochlorite exposure (10ppm for 1 hr) will also provide control
- EO or PO are other technologies used for smaller batches of product





# ***Packaging & Delivery Systems***

- Most common to package in 50 lb bags, on pallets which are stretchwrapped with plastic film.
- Some shipment in supersacks, bulk truck or railcar-These modes require special care be taken to eliminate possibility of contamination and maintain bacterial control.
- Storage has to be in dry warehouse with appropriate controls for wildlife.
- Shelf life is limited to two years if the product is kept in stretch wrap.



## ***Talc Applications('000 tons/yr)***

<b>Area</b>	<b>NA</b>	<b>Europe</b>	<b>Asia</b>
<b>Paper</b>	<b>100</b>	<b>600</b>	<b>2,000</b>
<b>Plastics</b>	<b>180</b>	<b>280</b>	<b>450</b>
<b>Paint</b>	<b>140</b>	<b>200</b>	<b>500</b>
<b>Ceramics</b>	<b>130</b>	<b>150</b>	<b>450</b>
<b>ACS</b>	<b>120</b>	<b>90</b>	<b>250</b>
<b>Cosmetics</b>	<b>35</b>	<b>45</b>	<b>250</b>



# ***Talc Applications-Paper***

- **Filling**
  - 10 micron median, product-clean on 325
  - now primarily in Asia but declining rapidly (alkaline sizing)
- **Coating**
  - 2.5 micron median in slurry form
  - primarily in Europe for rotogravure & declining
- **Pitch Control**
  - 3.5 micron microcrystalline
  - biggest use in NA - stable



## ***Talc Applications -Plastic***

- Reinforcing polypropylene for automotive applications
- Range from 200 mesh dark to micronized white product
- Japanese technology-growing rapidly
- Nucleation and particle shape





## ***Talc Applications-Paint***

- Prime anticorrosive pigment in marine coatings
- Sandability in auto refinish and gelcoats
- Flatting agent in semi-gloss
- Barrier pigment and stain blocker in primers
- TiO<sub>2</sub> spacer and extender pigment in interior flats
- Rheology modifier for water and oil based



# ***Talc Applications-Ceramics***

- Component of cordierite bodies where it assists porosity and extrudability
- Component of high porosity earthenware bodies for wall tile and hobbyware
- Main component of low loss electrical whiteware bodies
- Flux for fast fired porcelain tile, alumina and glazes



# ***Talc Applications-Cosmetics and Personal Care***

- Main ingredient of baby, body and foot powders (mainly a second and third world business)
- Key ingredient in face powders, blushes, eye shadows etc
- Detackifying ingredient in citrus flavored chewing gum
- Lubricant in production of tablets
- Minor excipient in the production of tablets
- (White) ingredient in tablet coatings



# **WW Talc Supply for Cosmetics and Personal Care**

- Worldwide main supplier is China, followed by India, USA, France, Brazil, Pakistan/Afghanistan and others
- Most Chinese based product is purchased as ore in China, shipped as ore to mills in Japan, USA, EU etc and milled, heat treated and packaged in those countries
- Most Indian ore is milled and packaged in India and used there or exported in packaged form (20 kg bags)
- In France and Brazil, it is mined, processed and packaged domestically





# ***US Talc Supply for Cosmetics and Personal Care***

- A significant portion is produced domestically by MTI, beneficiated by froth floatation in Montana and shipped to powder, chewing gum and pharma customers within the US.
- Another portion is produced by Imerys in Montana, beneficiated by friction sorting and then milled and heat treated in Houston for use in chewing gum and foot powder
- Most of the balance is sourced from imported Chinese ore, milled, heat treated and packaged in the US
- A small portion consists of finished product, milled and packaged elsewhere and imported into the US from Brazil, China, India, France, Japan, Italy and the UK



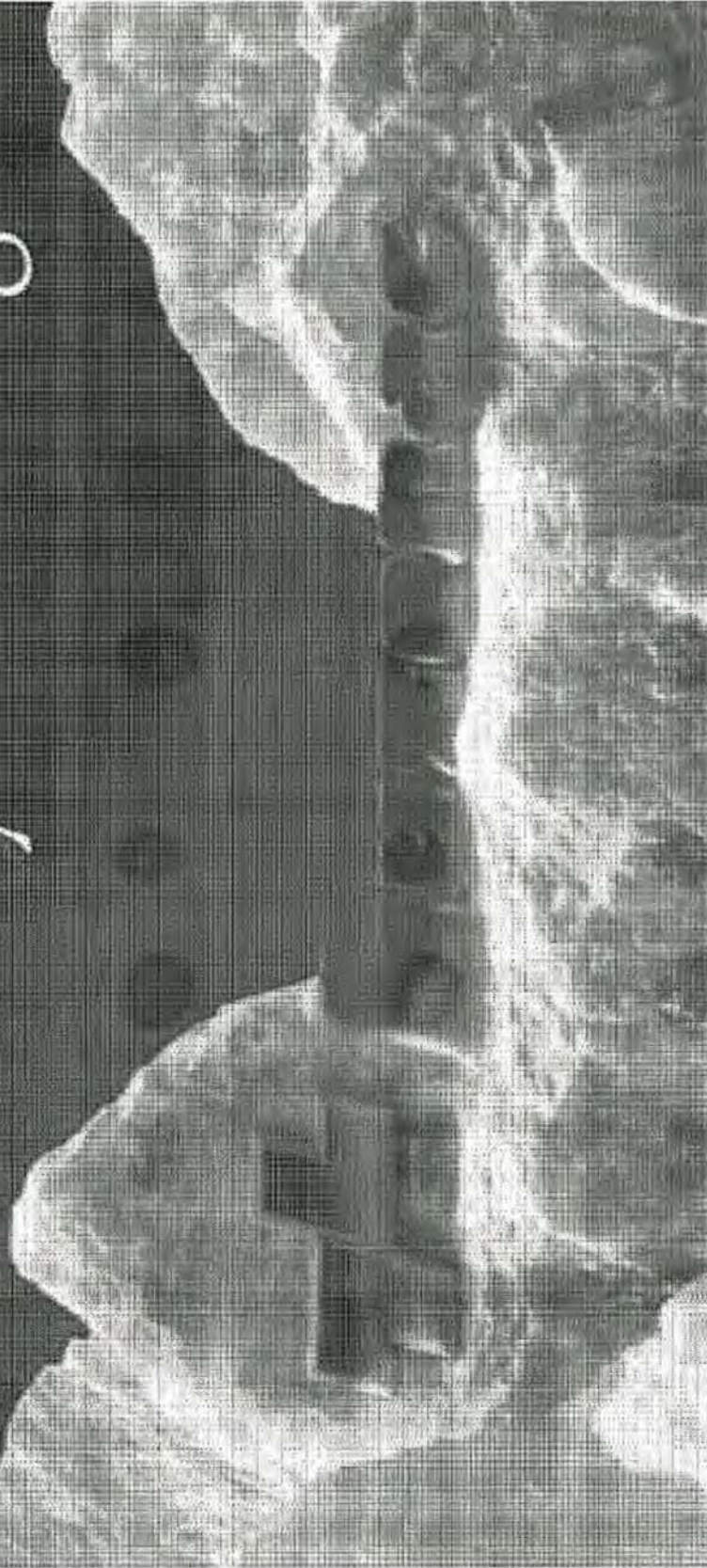
# ***Luzenac Business Practices***

- We operate our business in a sustainable manner
- We set money aside each year to reclaim our mines
- We do not sell products containing asbestiform minerals
- We place a very high emphasis on employee safety and training
- We are respectful to our customers, employees, contractors and the communities we operate in.





# Shaping a mineral to industry's advantage



**IMERY**